Radio transient phenomenon - the moment of birth of the radio source?

Magdalena Kunert-Bajraszewska

in collaboration with:
Aleksandra Wołowska (UWM, Poland)
Kunal Mooley (Caltech, NRAO, USA)
Preeti Kharb (NCRA-TIFR, India)
Amy Kimball (NRAO, USA)
Daniel Stern (Caltech, USA)
Kristina Nyland (NRL, USA)
Aneta Siemiginowska (SAO, USA)
Dorota Kozieł-Wierzbowska (UJ, Poland)
Aleksandra Krauze (UMK, Poland)

UNIWERSYTET MIKOŁAJA KOPERNIKA W TORUNIU

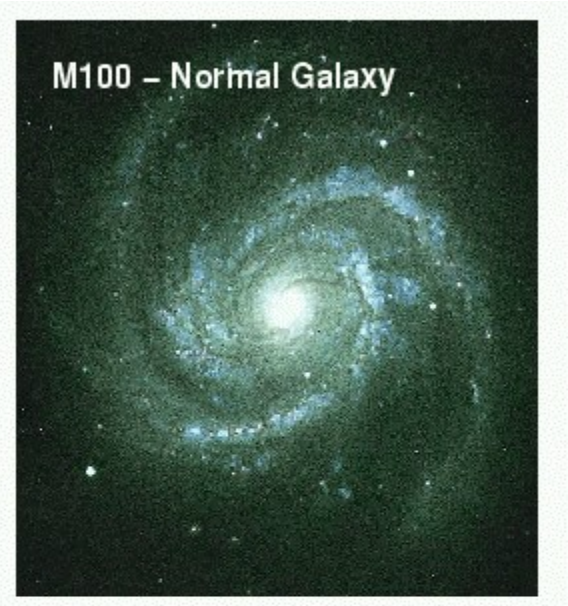
Institute of Astronomy, Nicolaus Copernicus University, Toruń, Poland

Radio-quiet and radio-loud

Galaxies

7%
Active Galactic Nuclei (AGN)

93%
non-active galaxies

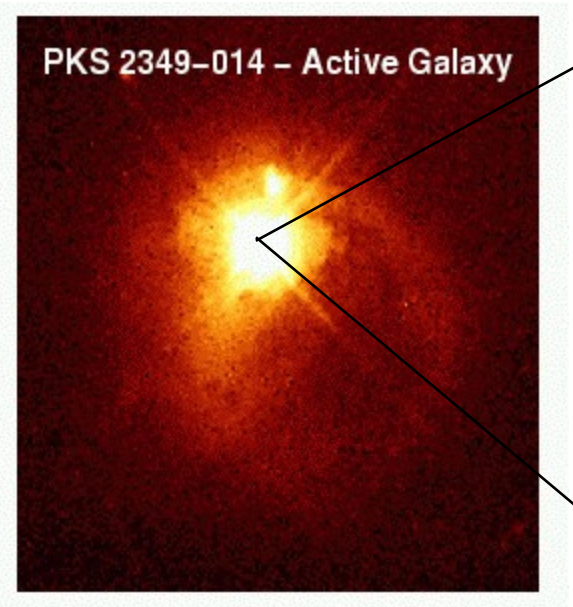


Radio-quiet and radio-loud

Galaxies

7%
Active Galactic Nuclei (AGN)

93%
non-active galaxies



Radio-quiet and radio-loud

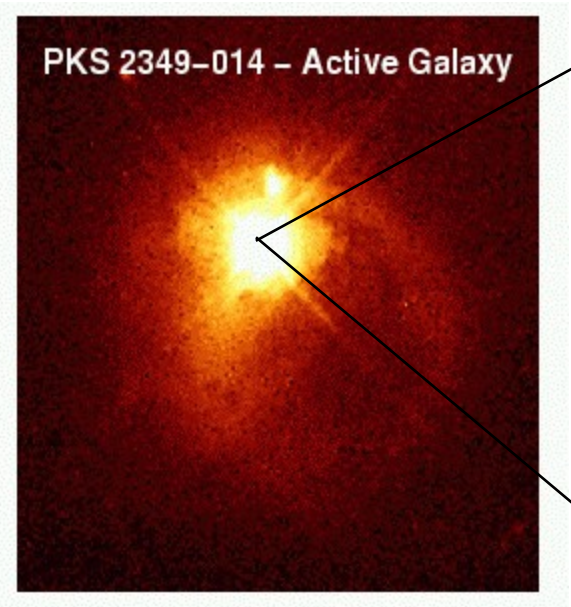
Galaxies

7%
Active Galactic Nuclei (AGN)

93%
non-active galaxies

90%
radio - quiet

10%
radio - loud



Radio-quiet and radio-loud

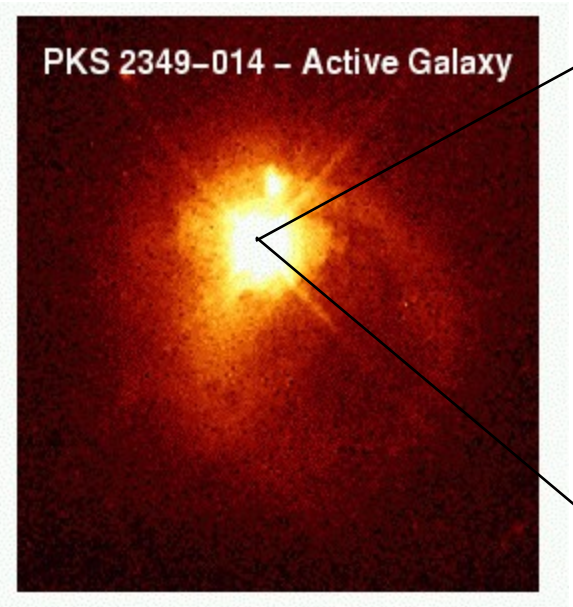
Galaxies

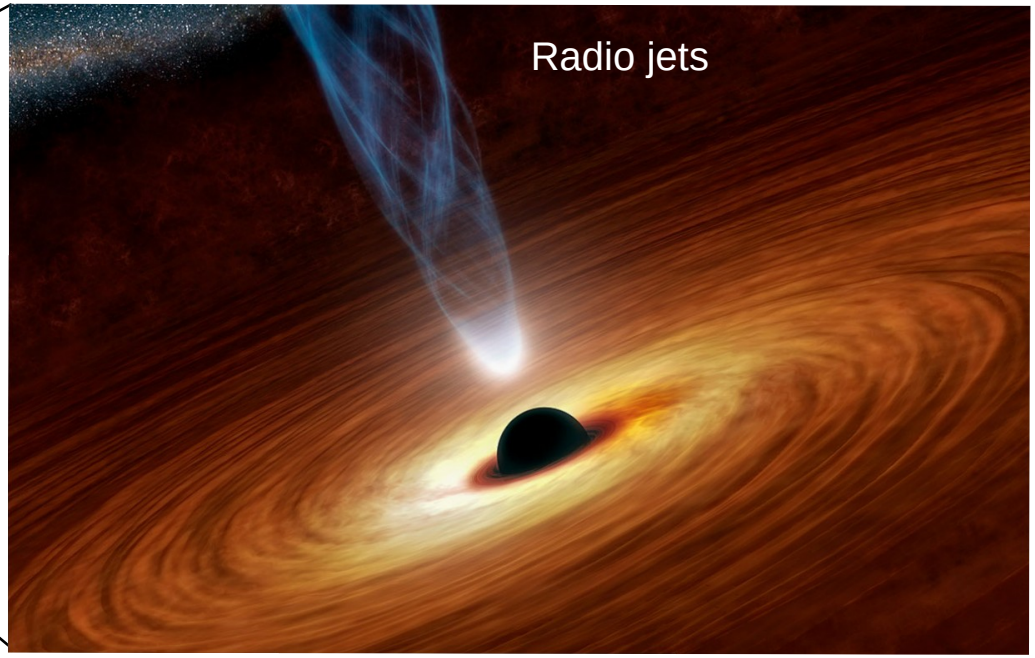
7%
Active Galactic Nuclei (AGN)

93%
non-active galaxies

90%
radio - quiet

10%
radio - loud





Radio-quiet and radio-loud

Galaxies

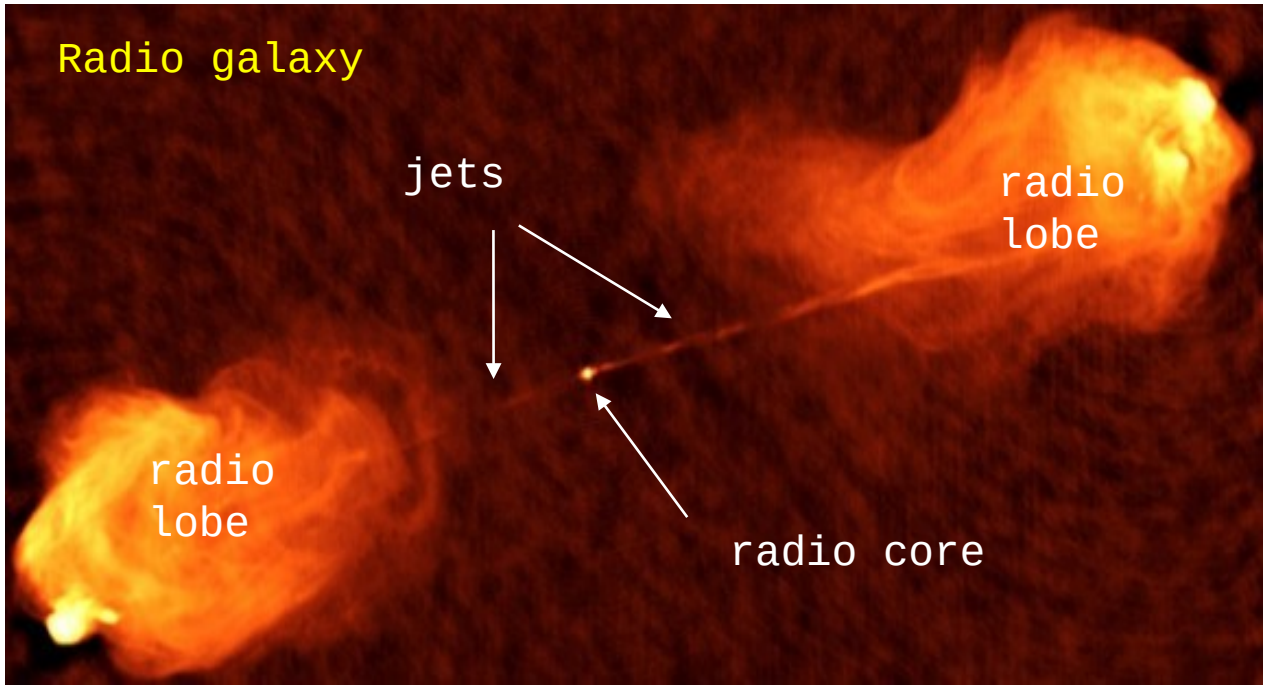
7%
Active Galactic Nuclei (AGN)

93%
non-active galaxies

90%
radio - quiet

10%
radio - loud

Typical structure of radio galaxy



Motivation of our studies

Questions:

- What ignites the radio activity?
- Can we detect and trace the birth of radio activity (i.e. the transition from radio-quiet to radio-loud state) ?

Motivation of our studies

Questions:

- What ignites the radio activity?
- Can we detect and trace the birth of radio activity (i.e. the transition from radio-quiet to radio-loud state) ?

What we need to answear them:

- Knowing how to identify a young radio source.
- Sensitive time domain radio surveys.
- A statistically significant sample of objects.
- Follow-up deep multiwavelength observations in order to classify and characterize correctly the transient object.

The phase space of slow extragalactic radio transients

Caltech – NRAO Stripe 82 Survey (CNSS)

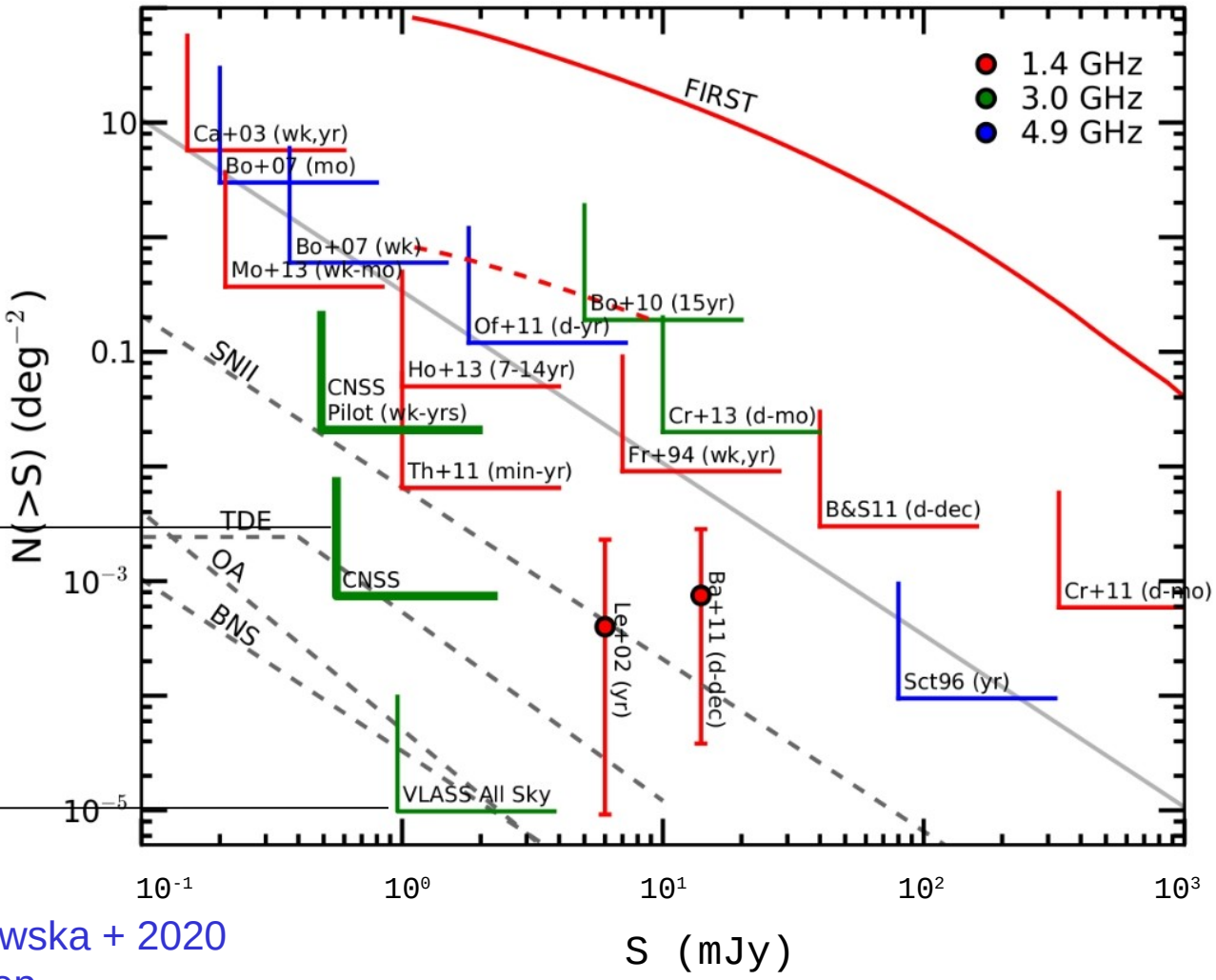
Kunert-Bajraszewska+2020

Wołowska +2021

VLA Sky Survey (VLASS)

Nyland,…, Kunert-Bajraszewska + 2020

Kunert-Bajraszewska, in prep.



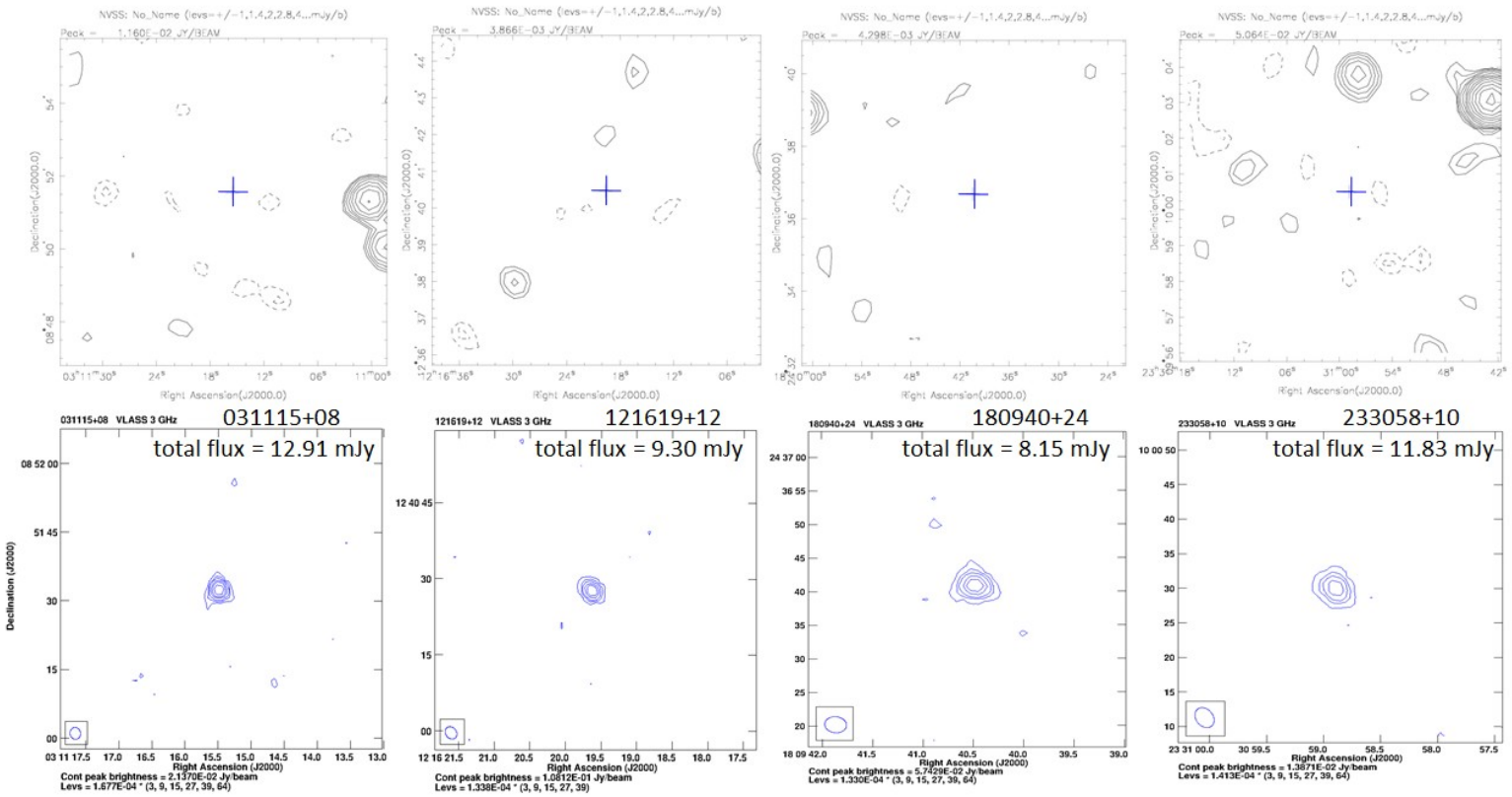
Mooley+2016

What we found

Distinct population of AGNs not detected as radio sources in any of the previous radio surveys.

1995

2017



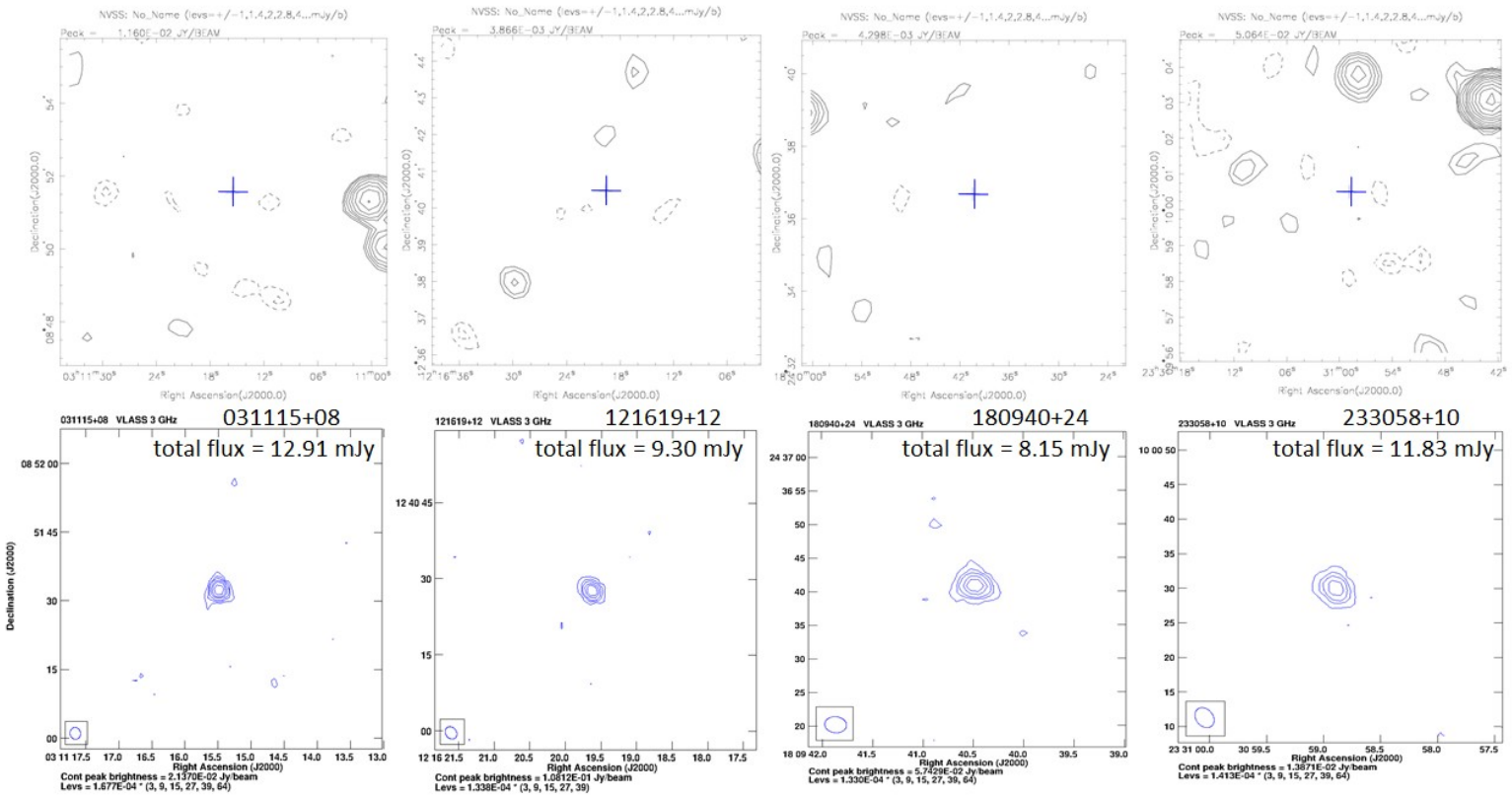
Sources that transitioned from radio-quiet to radio-loud state

What we found

Distinct population of AGNs not detected as radio sources in any of the previous radio surveys.

1995

2017



The folow up multi-epoch and multi-frequency study:

Radio: VLBA, VLA, GMRT

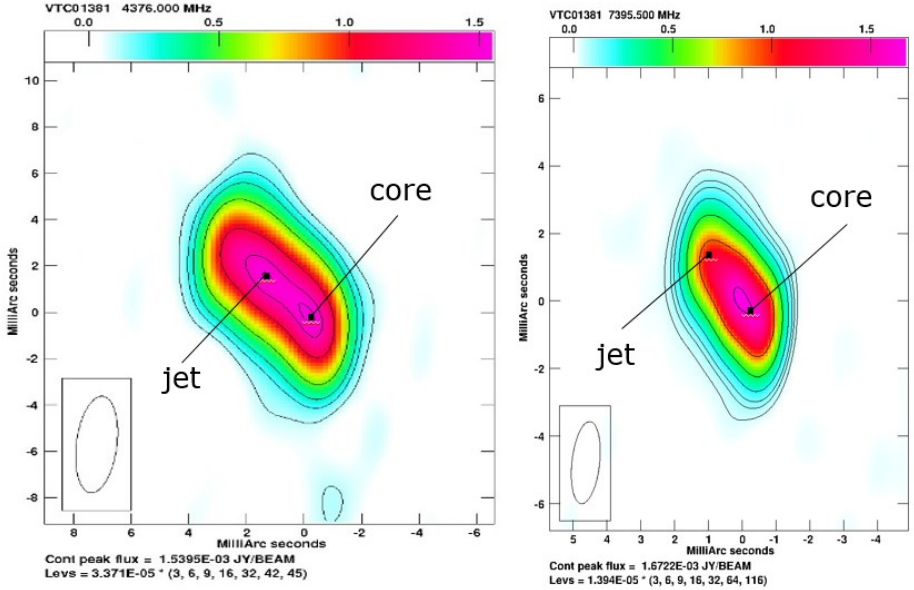
X-rays: Chandra, XMM-Newton

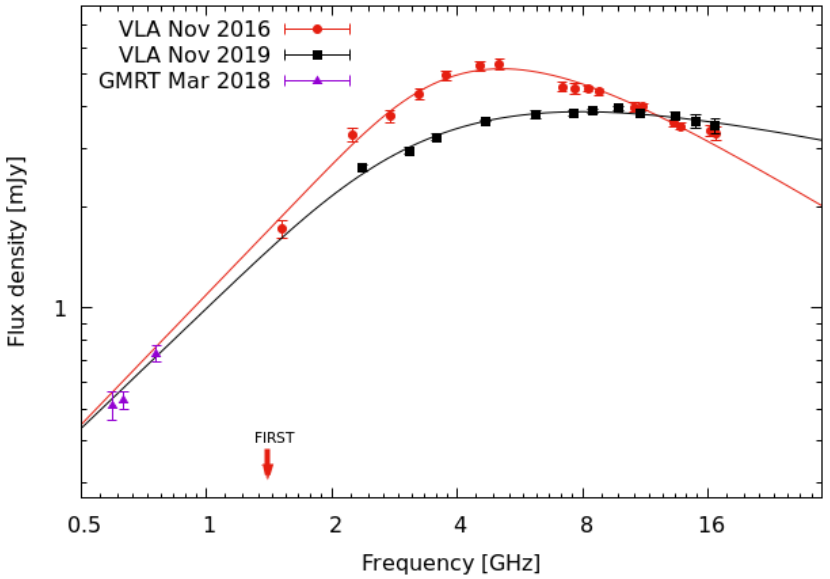
Infrared: WISE

Optical: SALT, SDSS, Keck, Palomar

The birth of radio quasar 013815+01

Kunert-Bajraszewska+2020



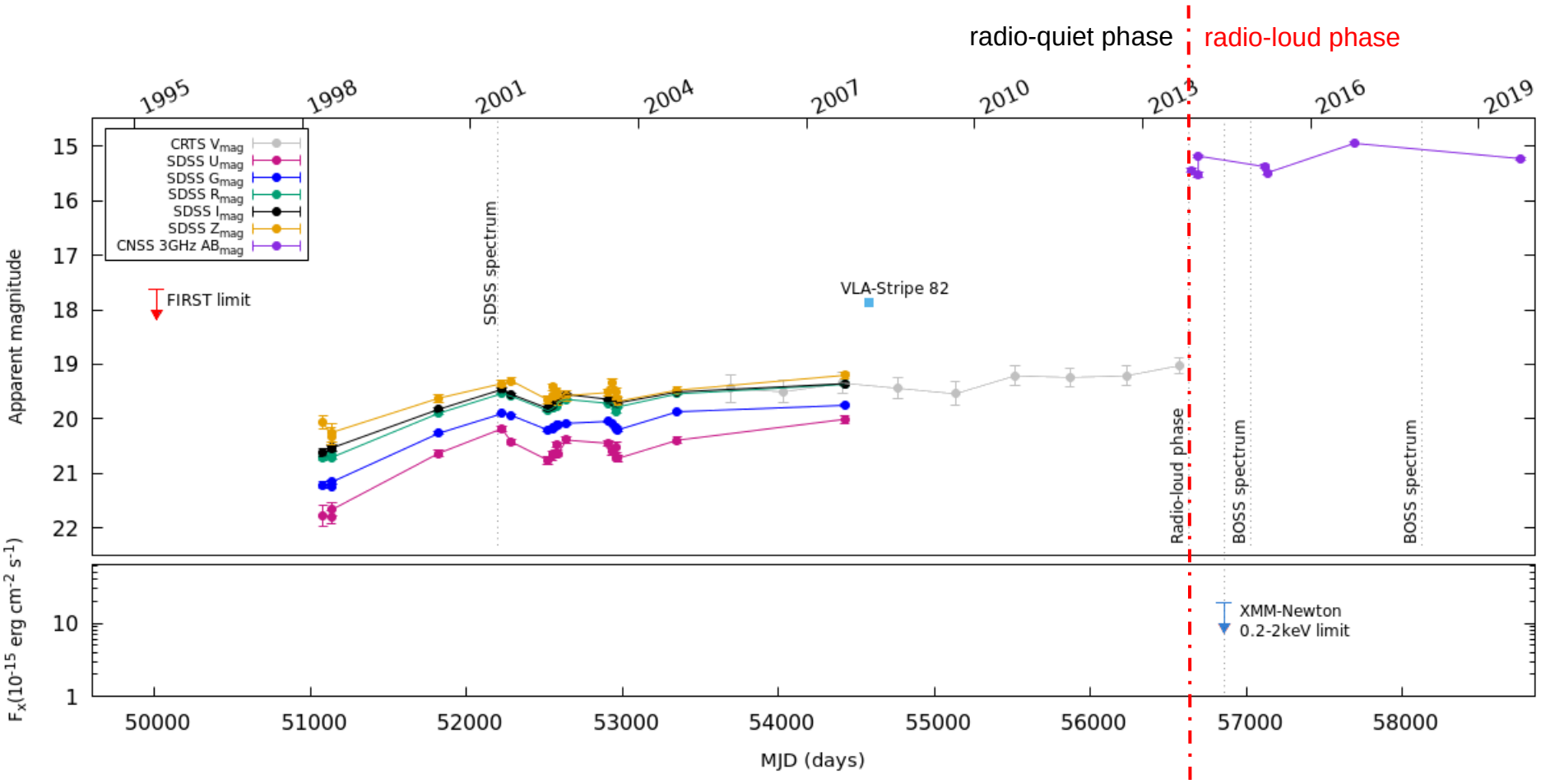


- Discovered as a radio source on 12.12.2013.
- Core-jet radio structure.
- It went through the short gigahertz-peaked spectrum phase at the beginning of its activity and has now stabilized its flux density at the level of a few mJy.
- AGN with 10^9 $M_\odot$ black hole.

- Transition to the radio-loud mode coincides with changes of its UV–optical continuum and the low ionization Mg II broadline.

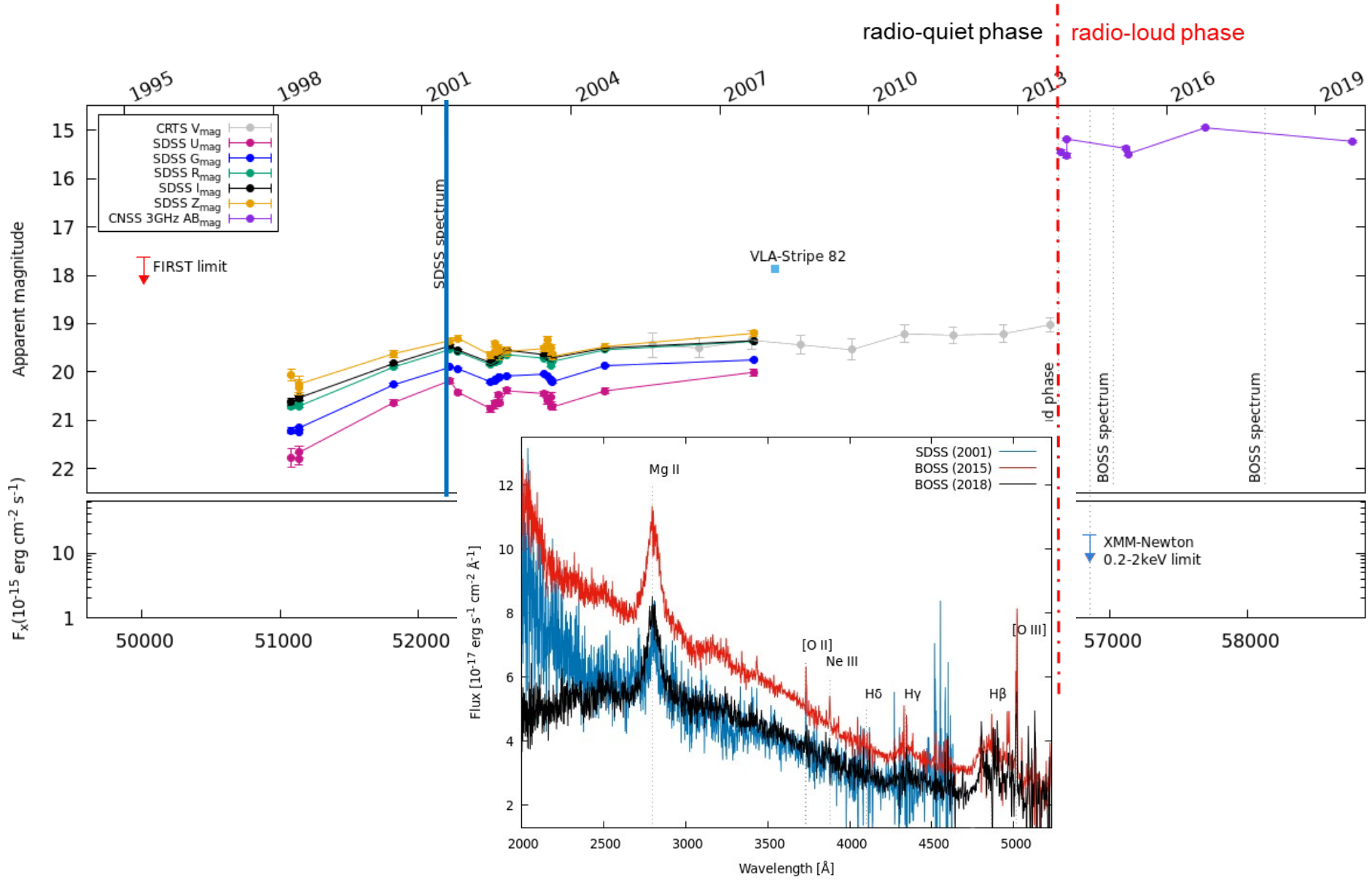
The birth of radio quasar 013815+01

photometric recording



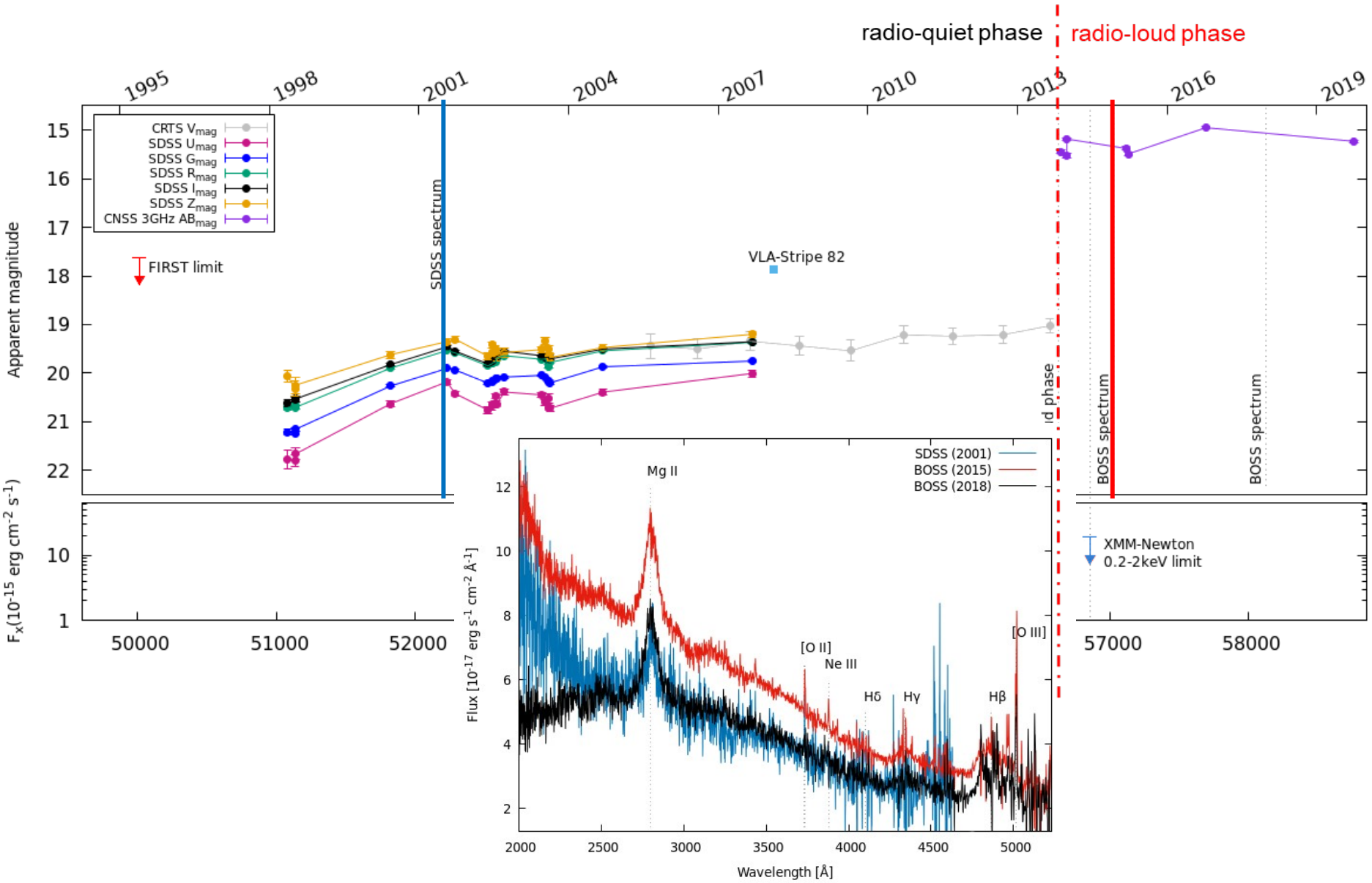
The birth of radio quasar 013815+01

photometric recording



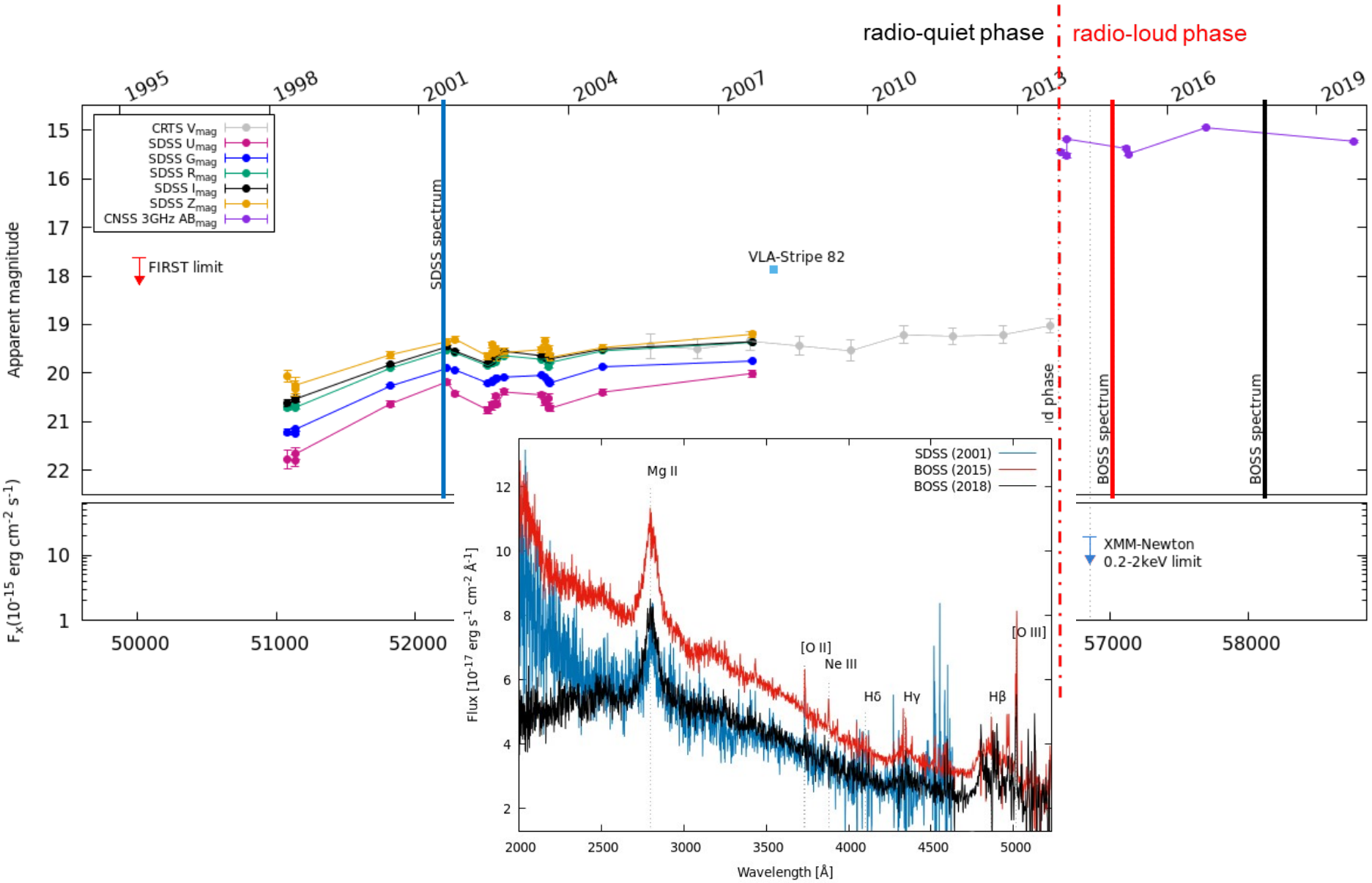
The birth of radio quasar 013815+01

photometric recording

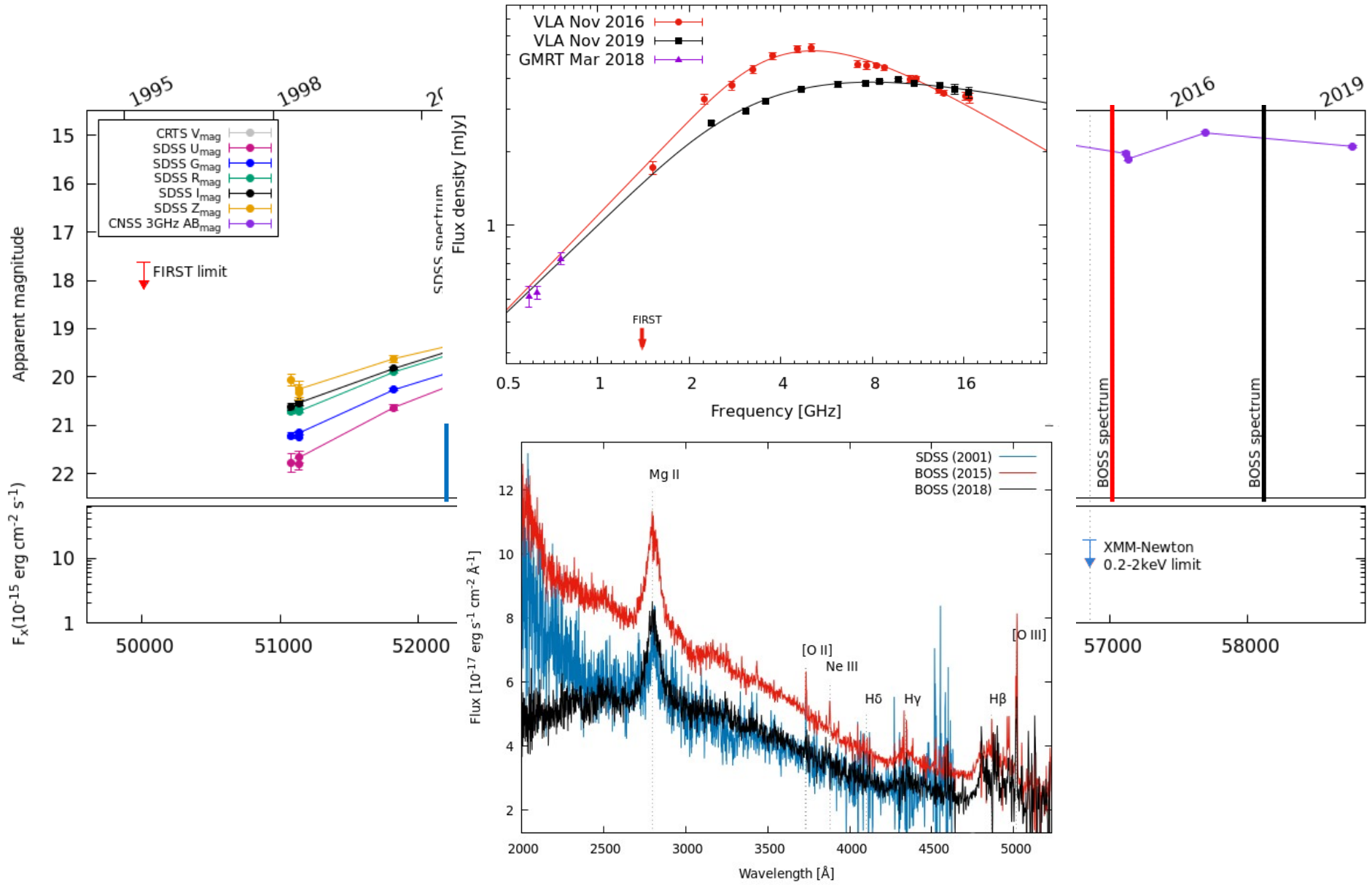


The birth of radio quasar 013815+01

photometric recording



The birth of radio quasar 013815+01



Summary

- The discovered radio sources might have transitioned from a radio-quiet to radio-loud state either as a result of the increase in radio power or its ignition after > 5–20 years of absence.
- Their radio characteristic indicate that they are in early life stage.
- Changes in the accretion disk happen on the much shorter timescales than the lifetime of the newborn radio source.
- There are differences in the behavior and development of the radio structure and spectrum of galaxies and quasars.

More data in the optical-UV and X-ray regime is needed.

The work on other, new samples and deep multi – frequency data is in progress.

Thank you!

UNIWERSYTET
MIKOŁAJA KOPERNIKA
W TORUNIU

Institute of Astronomy, Nicolaus Copernicus University, Toruń, Poland

The life cycle of radio-loud AGN

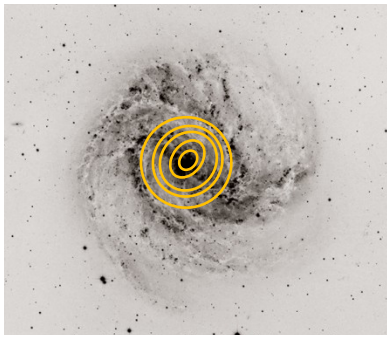
GPS (<1kpc) → CSS (<20kpc) → FRI/FRII(>20kpc)

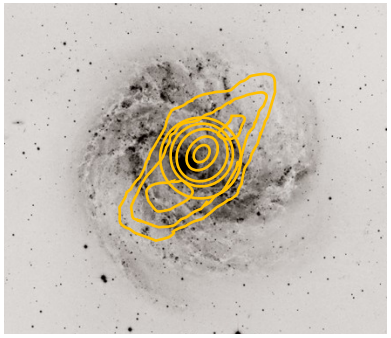
Gigahertz
Peaked
Spectrum

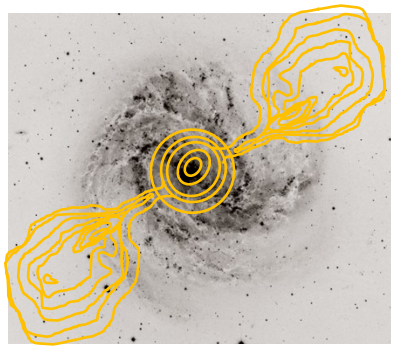
Compact
Steep
Spectrum

Fanaroff-**R**iley **I**
Fanaroff-**R**iley **II**

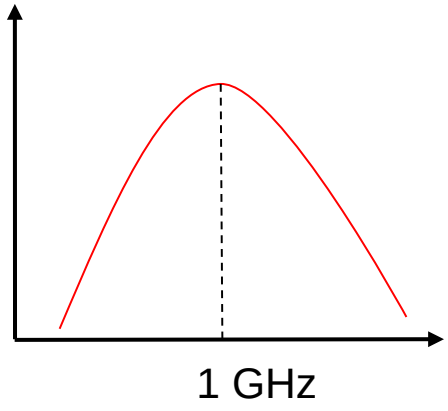
changes in radio structure

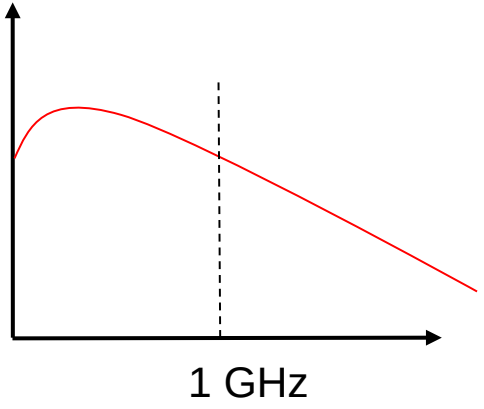






changes in radio spectrum

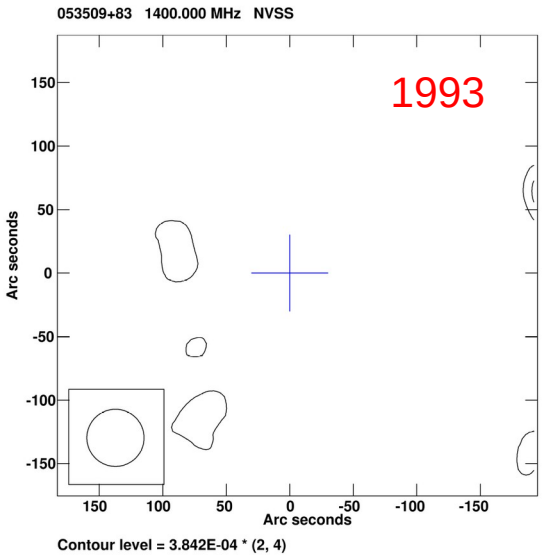


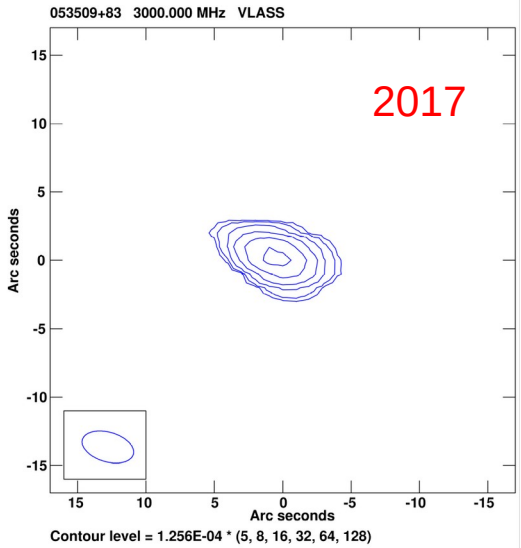


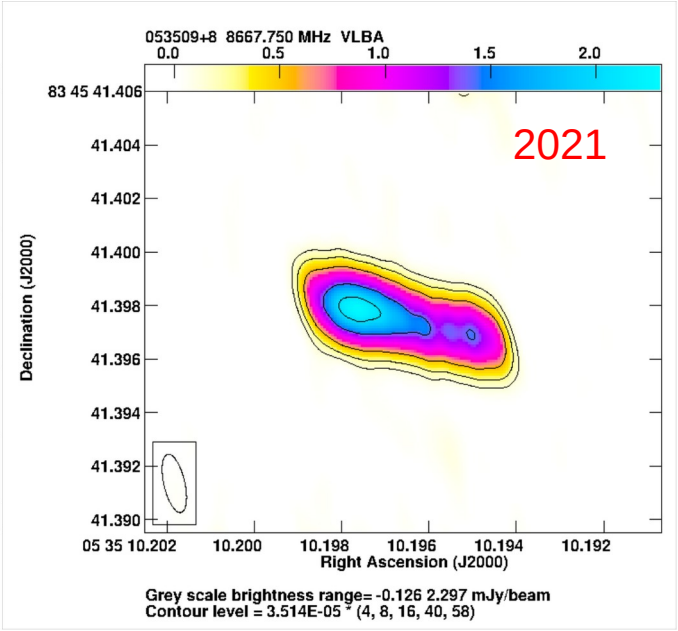
Time (years)

10^3 10^5 10^8 - 10^9

Sources that transitioned from radio-quiet to radio-loud state







The folow up multi-epoch and multi-frequency study:

Radio: VLBA, VLA, GMRT

X-rays: Chandra, XMM-Newton

Infrared: WISE

Optical: SALT, SDSS, Keck, Palomar